

Artificial Intelligence and Big Data as Risk Management Tools in Public Services: Opportunities, Challenges, and Practical Insights

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Abstract

This paper explores the integration of Artificial Intelligence (AI) and Big Data as innovative mechanisms for risk prevention and management within public services. It examines how these technologies enable real-time data analysis, identification of patterns and trends, and prediction of potential risks, thereby enhancing decision-making and operational efficiency. The study highlights both the opportunities—such as improved service quality, reduced costs, and proactive risk mitigation—and the challenges, particularly concerning data privacy, infrastructure security, and skill requirements. While the conceptual framework underlines the theoretical contributions of AI and Big Data, the paper also considers the need for practical applications and case-based studies that can validate these technologies in real-world public sector environments. By analyzing use cases including critical infrastructure monitoring, natural disaster forecasting, and fraud detection, the paper argues that AI and Big Data hold significant promise for reshaping risk management practices in public administration.

Keywords: Artificial Intelligence; Big Data; Risk Management; Public Services; Predictive Analytics; Decision-Making; Operational Efficiency; Data Privacy.

1. Introduction

The use of artificial intelligence and BIG DATA for risk prevention and management in public services is growing quickly. They are increasingly being used to make use of vast quantities of data collected by public services in stronger risk management. The two together have many possible benefits, but combined with them also present significant challenges that need to be considered. This study examines the different applications during the use of artificial intelligence and BIG DATA in public services, and the challenges and benefits of doing so.

This research is intended to investigate how artificial intelligence and BIG DATA can be incorporated into risk prevention and management within public services, with the purpose of examining the real time applications of AI and BIG DATA and their capability for providing predictive risk potential. The research also intends to gain insight into how BIG DATA can be gathered, stored, and analysed to enhance decision-making and operational effectiveness within public services. Objectives also include identifying challenges tied to the adoption of these technologies, including privacy and sensitive data protection, system and infrastructure security,

and training and skills. Lastly, the research considers possible benefits surrounding the integration of artificial intelligence and BIG DATA including more effective risk prevention, reduced risk management costs, and improved quality of public services. Possible use cases for these technologies are also explored as an illustration of their risks prevention and managing capability.

Issues

The challenge in utilizing BEST DATA in AI/Risk Management for the public service sphere is the consolidation of two domains of knowledge and practice in the public sphere, and that these two domains are subsequently underpinned by multiple specificities of their own. The challenge can be technical, in relation to data procurement and management, to ethical (or regulatory) issues which focus on security and confidentiality. The public sector is by definition pursuing the ultimate good so it needs efficient risk and management tools and informed decision-making. How can BEST DATA in AI be applied to determine on real time data? Identify patterns and trends, and forecast potentials risks? How does massive data engage with be collected and stored safely? How is the data analysed to prove informed decision? How do privacy and sensitive data interfaces with these advanced technology applications? What skills are necessary to integration? What benefits could potentially derive from integration such as more effective risk management, cost efficiencies, and greater service quality? Finally, what are the potential uses of AI and BEST DATA in risk management in the public service domain? These questions are the focus of this research, which aims to explore the opportunities and challenges of integrating artificial intelligence and Big Data in this crucial area.

2. Conceptual Framework

a. Definition of artificial intelligence

Artificial intelligence (AI) is defined as the capacity for a machine to replicate human cognitive abilities such as learning, reasoning, recognizing patterns and solving problems. AI employs sophisticated algorithms and statistical models to interpret and analyse data, and to autonomously make decisions. It can be applied to automate tasks, recognize

trends and patterns in data, and predict and prevent risks. AI has tremendous potential for application in public services, providing, in particular, a higher level of data analysis and a better capacity to prevent risk. (Agbor, 2024) Approaches such as machine learning and deep learning suggest that AI will continue to develop and provide, increasingly, higher and higher levels of performance. It can handle large amounts of data and produce results that are reliable and accurate. AI can also handle intelligent systems that can naturally and intuitively interact with users, thus expanding possibilities in robotics, home automation, and virtual assistants.

Furthermore, artificial intelligence is generating discussions around ethical and social implications of its use in terms of privacy, security and assignment of responsibility for decisions made by machines (DJELLABA & BENAMARA). However, in spite of these legitimate concerns, AI continues to develop and transform many areas, bringing considerable benefits to sectors such as medicine, finance, industry and transport. With consistent progress and increasing take-up, AI is poised to grow in significance in society and in our daily lives (Mezati & Otmani).

b. Definition of BIG DATA

BIG DATA relates to the immense data sets that are being collected from various sources, such as social networks, sensors, mobile devices and utility information systems. BIG DATA is defined by the immense volume, the wide variety, and the significant velocity of the data. BIG DATA calls for highly complex techniques to collect, store, analyse and visually present, to acquire highly valuable and useful particulars. A critical analysis of Big Data can reveal patterns, trends, and associations, that would otherwise be practically impossible (or at least difficult) to reveal. In the critical area of risk omission and management in public services, BIG DATA has a significant role to play in the operations space, which provides essential, and strategic information for evidence-based decision-making, improves performance and dramatically improves operational productivity. (BELHAJ2023)

3. Using artificial intelligence to prevent risks

Artificial intelligence (AI) has vast potential to enhance risk prevention in public services. AI represents a blending of risk management and AI, and also creates a wide range of possibilities where robust analysing and treatment are possible. Risk management is a staged and interlinked process that involves many analysis operations. The autonomous analysis capabilities of AI's advanced algorithms allow for extensive risk management analyses. AI allows for fast and correct identification of repeating data patterns that allow managers to infer useful conclusions about each of the data sets they are analysing. AI also permits managers to predict potential risks based on the data settings that describe emerging trends. The consumption of these expectations illuminate the actions that need to be taken to mitigate risks in public services. (BOUSHABA and CHAKOR2023)

a. Real-time data analysis

The analysis of data in real-time is a crucial part of how utilities use artificial intelligence (AI) for risk prevention. The analysis in real-time shorten the amount of time to process large sets of data from various data sources and gets fast results. Risk indicators are detected and managed in real time and as quickly as possible. This means that risks are continually monitored and actions can be taken in a timely manner. The ability to analyse quickly and accurately in real time helps reduce risk and maintain safety for vital public services. (Nicolas, 2023)

b. Identifying patterns and trends

The use of AI in support of risk management processes is ultimately data focused. It permits a precise examination of data as well as observations of patterns that may exist within a data set. The capacity to understand patterns and trends leads to risk factor awareness fundamentals and allows for customized targeted prevention measures. For instance, specific prevention measures can be made when suspicious patterns of behaviors are observed in the data in order to avoid an incident or incident issues. So, AI assists and improves risk prevention capabilities where public service is concerned (Agbor, 2024).

c. Prediction of potential risks

Anticipating possible risks become a noteworthy aspect of Artificial Intelligence (AI) in risk prevention for public utilities. Through the utilization of advanced algorithms to analyze data, AI makes it possible to predict possible risks with greater accuracy. The predictive aspect allows us to anticipate the expected risks and take the necessary precautions while ensuring public utilities are safe. For instance, predictive models created via analysis of past data could allow us to anticipate risk of breakdowns or failures in public utilities, enabling us to make preventative interventions that could limit disruptions to users. While using AI for predicting possible risks, an effect contribution to managing risk proactively emerges within the context of public utilities services. (BOUSHABA and CHAKOR2023).

4. BIG DATA and risk management in public services

BIG DATA is significant in risk management in public services. Millions of data can be collected and stored and analyzed and understood risk far better than reference checking. This wealth of BIG DATA will increase knowledge to support decision-making, through recognizing patterns and trends that might identify a risk issue. In addition, the interrogation of BIG DATA can drive efficiency in operations, to identify areas for change or improvement. By combining artificial intelligence and BIG DATA, public services can become more preventative and reactive in risk prevention techniques. (Bentalha2020)

a. Collecting and storing massive data

The collection and storage of massive data are vital components of risk management in the public service domain. Government agencies are utilizing and collecting massive quantities of data from sources such as environmental sensors, monitoring systems, and already existing databases. This massive data is storied in suitable infrastructures, ensuring its safety and accessibility to all. The effective and efficient collection and storage of massive data provide public services with critical information for assessing risks and decision-

making to mitigate and manage those risks. (Jacob et al., 2022) (Jacob, 2020) (MENASRIA, 2022).

b. Data analysis for better decision-making

Data analysis is at the core of public services' risk management decision-making process, as the vast amount of data compiled is analysed using advanced algorithms and Artificial Intelligence techniques to extract the most useful information. The data analysis identifies patterns and trends that may identify possible risk. Therefore, utilising this information, utilities managers may stay ahead of the risk curve to effectively manage risk prevention and mitigation. Data analysis is therefore an effective and useful tool for improving the responsiveness and effectiveness of utility action in risk management (Jacob and Souissi2020) (RARHOU, 2023).

c. Improving operational efficiency

The blending of artificial intelligence and BIG DATA with the risk management of utilities leads to enhanced operational performance. Examining large data sets can lead public authorities to find gaps and limitations in their current practice. Public authorities can then analyze this data to uncover areas for potential changes or improvements to be more resilient to and better prepared for risks. The application of artificial intelligence and BIG DATA therefore facilitates the creation of corrective action and efficiencies to improve risk management and emergency response. (ACHIR & DOUARI, 2024).

5. The challenges of integrating artificial intelligence and BIG DATA

Integrating artificial intelligence and Big Data into risk prevention and management for public services presents a number of challenges. These include the protection of privacy and sensitive data, the security of systems and infrastructures, and the necessary training and skills.

a. Protection of privacy and sensitive data

The combination of artificial intelligence plus BIG DATA introduces significant risks regarding the protection of a person's privacy and sensitive data. A collection of a significantly larger volume of data raises concerns over

confidentiality for the individual providing that data. Thus, it is critical to ensure sufficient protective measures are in place to confuse that data and protect personal confidentiality. Additional security protocols must be established to provide strict protections of personal data, ensuring that only authorized individuals have access to data, and sensitive data is treated and handled securely and appropriately (BADDUOH and SOUDANE2024). Public services that utilize artificial intelligence and BIG DATA must similarly pay attention to the security of their systems and infrastructures. IT security attacks and breaches of privacy, can significantly affect the overall risk management process through diminished risk perception and prevention (Schumacher, 2021). Vulnerable IT infrastructure risk impact public services ability to protect assets of a limited infrastructure and would compromise the overall nature of the mega-system. It is critical that firm security protocols are utilized for the security of infrastructures and systems utilized for collecting, storing, and analyzing data and managing those systems against external threats. Security protocols should likewise continue detect and prevent attacks.

b. Training and skills required

The integration of artificial intelligence and BIG DATA into risk prevention and management necessitates professional training and skill. Individuals engaged in public services need a thorough understanding of AI, BIG DATA and relevant technologies, and need to be able to collect, analyse and interpret data in an accurate and appropriate way. They also require education on the ethical principles and best practices that should accompany the use of AI and BIG DATA to ensure that this technologies are used responsibly in risk prevention and management.

6. The potential benefits of integrating artificial intelligence and BIG DATA

The amalgamation of artificial intelligence and Big Data is an incredible avenue for benefiting risk prevention and management in public services. Through these two technologies, data can be executed and analyzed in real time making us feel more equipped to react to new and emerging

risks. Moreover, we are able to identify subtle patterns and trends which lead to detecting potential risks before any damage occurs. Last, integrating artificial intelligence and Big Data will allow us to forecast risks in the future, which will enable public services to take preventative measures to avoid the risks in the first place. By combining artificial intelligence and BIG DATA, public services can therefore, take advantage of better risk prevention. (BELHAJ2023)

a. More effective risk prevention and improving quality of public services

The fusion of artificial intelligence and BIG DATA generates possibilities for optimizing risk prevention within public service systems. By analyzing large amounts of information in real time, public services are able to detect emerging risks more quickly and take preventive actions that minimize or mitigate these risks. Furthermore, being able to detect emerging risks early means that pre-emptive and preventive action can occur before these risks become problems that are complex to mitigate, addressing a problem only after it has become more serious and expensive to deal with. Finally, the ability to identify risks that are anticipated reduces the ability to mitigate future economic losses by planning for investments and improvements in infrastructures. Therefore, the integration of artificial intelligence and BIG DATA provide a special opportunity to reduce the costs associated with risk management in public services. (ACHIR & DOUARI, 2024)The fusion of artificial intelligence and BIG DATA displays additional and augmented benefits, as these technologies will clearly enhance the quality of public services in risk prevention and mitigation efforts. Greater detail, capacity, and accuracy for analyzing large amounts of data with little time involved, these technologies support and enhance decision-making. Without these methods of assessing and better analyzing data, public services can progress and/or act on assumptions that may or may not be accurate. Public services may be able to reduce service interruptions and supply continuity of services in favorable quality, because they can detect emerging risks more quickly and respond with an appropriate intervention in the early stages of an emerging risk. Consequently, the integration of artificial intelligence

and BIG DATA contributes to the overall improvement in the quality of public services by strengthening their ability to deal with risks effectively and efficiently. (ACHIR & DOUARI, 2024).

7. Use cases for artificial intelligence and BIG DATA in risk prevention and management

There is much variation in how artificial intelligence and Big Data can be employed within public services for the purposes of risk prevention and management, including in the monitoring of critical infrastructure. With the capabilities of artificial intelligence and Big Data, it is now possible to assess data from these types of infrastructure in real time to detect anomalies and/or indications of malfunction, meaning that preventive action can be organized along with a proactive approach to risk management. Additionally, artificial intelligence and Big Data can be employed to predict natural disasters, whereby historical data is analyzed to uncover patterns and trends, making it possible to predict the risk of natural disasters, such as earthquakes, flooding or storms, to a high level of accuracy. Finally, artificial intelligence and Big Data can also be employed to identify fraud within public services. By analyzing large amounts of data, abnormal behaviours and patterns of fraudulent behaviours can be detected, thus enabling better prevention and combating of fraud.

a. Critical infrastructure monitoring

An example of using artificial intelligence and Big Data to monitor infrastructure is to prevent and mitigate risk to public service. In this instance, artificial intelligence and Big Data have built-in calculations and analytics of the data seen in this infrastructure in real time to monitor for malfunctioning or anomalies. This method provides authorities a chance to take preventive measures against potential risks to their infrastructures looking forward in time. For example, monitoring a power plants usage or performance, a power plant, or operator would observe an abnormalities increase or decrease in energy or equipment performance, which would give them a chance to conduct a preventive corrective maintenance and prevent a major failure. The overall

application of artificial intelligence and BIG DATA in monitoring critical infrastructure improves risk mitigation and continuity of service in public service delivery. MANSOURI & HADJERI, 2022

b. Forecasting natural disasters

Another use of artificial intelligence and BIG DATA in risk prevention and management in public services is forecasting natural disasters. The analysis and identification of patterns and trends in historical data can lead to an accurate forecasting of the risk of natural disasters (e.g., earthquakes, flooding, and storms). Using risk assessment criteria, agencies and authorities, utilizing machine learning models and algorithms, can model catastrophic events. An example of this could be when seismic, meteorological, and geographical data are combined, the potential precursor signals indicative of an earthquake may be identified, and advance warning can be made so that residents can prepare or evacuate (if necessary). This forecasting ability enhances risk management by greatly reducing potential loss of life, and associated material losses (ACHIR & DOUARI, 2024).

c. Detecting fraud in public services

Identifying fraudulent behaviour in the provision of public services is another application of artificial intelligence and BIG DATA. By monitoring BIG DATA, abnormal behaviour and patterns of fraud can be identified in the transactions and actions of public service provision. For example, if monitoring water or electricity consumption data, fraudulent behaviour can be identified if there are spikes in consumption or atypical consumption associated with water or electricity. Examples of this research are similar to a model which monitors credit card spending and/or financial transaction behaviour and the presentation of subject data would identify potential fraudulent spending patterns. The ability to identify fraud is a way to enhance prevention and action of fraud, thus reducing costs, and enhancing the public's use of services. (Bertolucci, 2023)(El Bour & Lebzar, 2020).

Conclusion

To conclude, there are numerous potential advantages to integrating Artificial Intelligence and BIG DATA into risk prevention and management for public services. There are significant advantages of using these technologies provide resources to analyze data in real-time and to detect patterns and trends to forecast potential risks whilst additionally collecting and storing vast amounts of data, facilitating decision-making by analyzing data, and improving efficiency into operations. However, as attractive as this integration may seem, it presents challenges in terms of protection of privacy and sensitive data, security into systems and infrastructures, and the requirement to train and develop capacity and skill sets. However, despite the challenges, there are very real opportunities to improve the effectiveness of risk prevention, reduce costs of risk management, and improve public service delivery through the integration of artificial intelligence and BIG DATA. Further, real-world use cases such as in the monitoring of critical infrastructure, forecasting of natural disasters, or fraud detection in public services provide evidence of the effectiveness of integration. For all these reasons, Artificial Intelligence and BIG DATA could be valuable resources for risk prevention and management in the public services arena, with much to gain and much to challenge.

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